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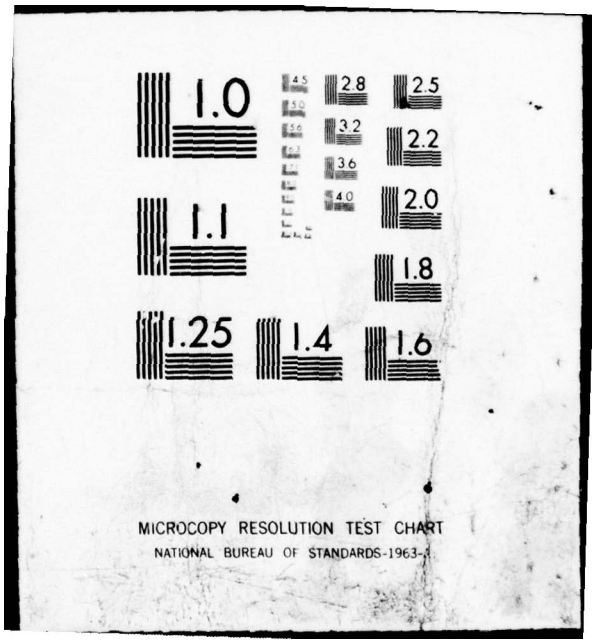
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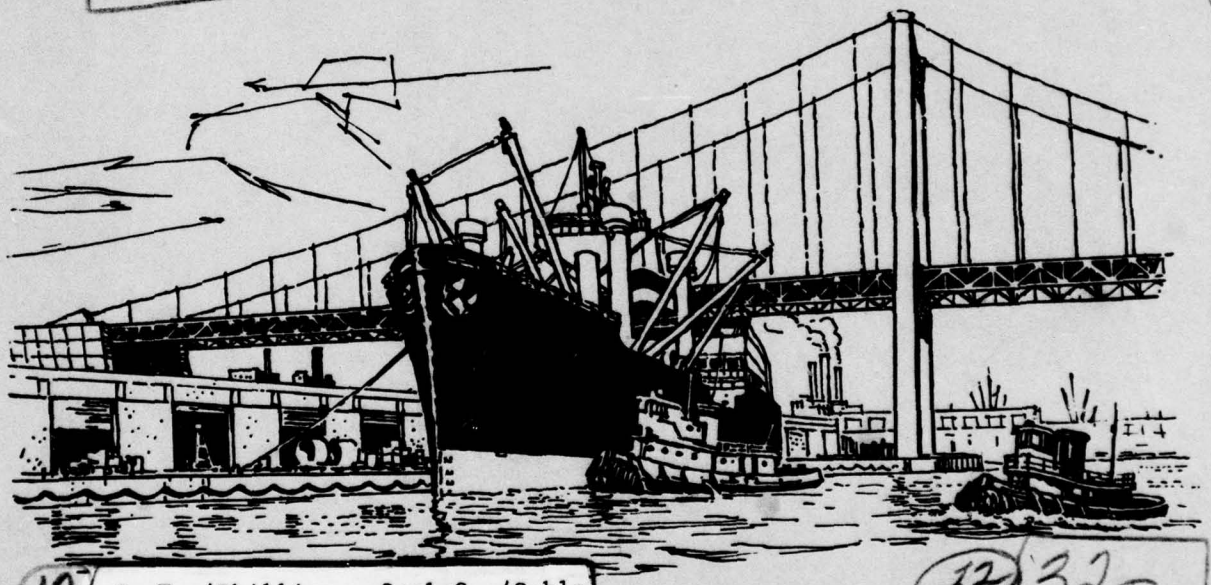
LONG RANGE SPOIL DISPOSAL STUDY.

PART VII.

SUBSTUDY 6.

DELAWARE RIVER ANCHORAGES,



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U.S. ARMY ENGINEER DIST.
PHILADELPHIA
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

(11) JUNE 1969

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TABLE OF CONTENTS

FOREWORD

This sub-study was undertaken as Part VII of the overall "Long Range Spoil Disposal Study" in the Delaware River. The overall study was conceived, created and completed under the Philadelphia District Engineers, Colonel W.W. Watkin, P.E. and Colonel James A. Johnson, P.E. who had been directed to such an effort by the Chief of Engineers.

This part of the disposal study was prepared by Messrs. J.F. Phillips, Carl C. Cable, Lewis Caccese, P.E., F.L. Sivard, P.E., and L.A. Duscha, P.E. of the Philadelphia District, and was undertaken by the Long Range Disposal Committee as a Value Engineering project. The principles and methodology of Value Engineering were employed in evaluating the authorized project and alternatives for improvement of the Delaware River Anchorages.

The study is divided as follows:

PART I - GENERAL DATA ON THE DELAWARE RIVER furnishes the information and data on the Delaware River which is pertinent to the entire study.

PART II - SUB-STUDY 1, SHORT RANGE SOLUTION evaluates the remaining disposal area capacity in terms of its remaining life, and to recommend any further desirable and acceptable disposal area developments.

PART III - SUB-STUDY 2, NATURE, SOURCE, AND CAUSE OF THE SHOAL develops in depth the basic data as to the nature of the Delaware River shoals, their sources, and their causes. It is hoped that this knowledge may reveal new concepts for the better control of shoals.

PART IV - SUB-STUDY 3, DEVELOPMENT OF NEW DREDGING EQUIPMENT AND TECHNIQUE identifies the best in dredging plant and dredging technique for Delaware River dredging maintenance tasks now and in the future.

PART V - SUB-STUDY 4, PUMPING THROUGH LONG LINES examines the merits of transporting dredged materials many miles through pipelines.

PART VI - SUB-STUDY 5, IN-RIVER TRAINING WORK determines the potential of training works for control of shoaling. It involves considerable model testing.

PART VII - SUB-STUDY 6, DELAWARE RIVER ANCHORAGES considers the effect of man-made anchorage on shoaling problems and the merits of alternate solutions.

SUMMARY

This is a reconsideration of the merits of enlarging Mantua Creek Anchorage and providing an improved anchorage off Reedy Point, Delaware and off Deepwater, Delaware as authorized by the River and Harbor Act of 3 July 1958. The reconsideration was made by analyzing current need, use of established anchorages, changing shipping patterns, the shortage of disposal areas, the multimillion dollar initial cost of anchorages, and their high maintenance cost. The report concludes that further investment in enlargement of anchorages would provide a benefit to cost ratio of .15 to 1 and is without merit from any reasonable viewpoint.

I INTRODUCTION

The Delaware River provides a commercial artery carrying over 100,000,000 tons of waterborne commerce a year over the improved portion from Trenton to the Sea. Improvements made by the Federal Govemment provide a 40-foot channel from the Atlantic Ocean to a point opposite Newbold Island and thence 25 feet on to the Trenton Marine Terminal, a distance of nearly 135 miles. Supplementing the main ship channel are 17 designated anchorage areas extending from Delaware Bay upstream to Philadelphia. Six of these anchorages are under Federal authorization. The remaining eleven being in naturally deep water for their intended purpose. Plate 1 shows the location of these anchorages. This study is intended to review the requirements for the six Federal anchorages as presently authorized.

The man-made anchorages, presently constructed at Port Richmond, Gloucester, Mantua Creek and Marcus Hook, are a significant factor in the present shoaling portions in the Delaware River. The longer anchorages at Marcus Hook and Mantua Creek have a great impact on disposal area problems at these locations, and the authorized improvement at Deepwater and Reedy Point will further aggrevate an already critical disposal situation. Construction of these anchorages will involve removal of approximately 40,000,000 cubic yards and add a maintenance load of 800,000 cubic yards to the present annual dredging requirements for this project. Clearly, the improvements not yet made must be restudied to determine if acceptable alternatives exist to reduce the volume of dredging required and conserve the remaining disposal area capacity for higher priority work in maintaining the main ship channel

II FEDERALLY AUTHORIZED ANCHORAGES

The need for anchorages in the lower Delaware River was demonstrated early in the project. Part I - General Data for the Delaware River, of the study contains a history of the development of the project. Federal legislative acts most pertinent to the anchorages are the 3 July 1930 Act which authorized anchorages at Port Richmond and Mantua Creek to a 35 foot depth and an anchorage at Gloucester, N.J. to a 30 foot depth. The Act of 30 August 1935 authorized a 35 foot deep anchorage at Marcus Hook. The Act of 2 March 1945 increased the depths at Mantua Creek and Marcus Hook to 37 feet and called for enlargement of these anchorages. Further, on 3 July 1958 this Act created new anchorages at Reedy Point and Deepwater Point, called for enlargement and deepening of Marcus Hook and Mantua Creek to 40 feet deep and 2300 feet wide with mean lengths of 8,000, 5,200, 13,650 and 11,500 feet

respectively. The District's report of June 1955, which formed the basis for authorizing these latter anchorages, concluded that there was a need for additional and improved anchorages as a means to assure full safe and economic use of the waterway. In support of these recommendations, studies were conducted which developed the existing and projected commerce, vessel traffic, anchorage use, accident records and a projected ratio of annual tangible benefits to annual costs of 1.03 to 1. A synopsis of each major separable reportable item is presented herein.

III WATERBORNE COMMERCE

The Philadelphia District's report of 1955 contained data indicating that commerce during the period 1941 to 1953, for the reach Philadelphia to the Sea, increased 95% from 30 to 58.5 million tons. During this same period, commerce between Philadelphia and Trenton, increased by 25% from 6 to 7.5 million tons. Projections of commerce were made, in the 1955 report for the Philadelphia to Trenton section, which indicated commerce would average 12.3 million tons over a 50 year period. No numerical projection for commerce over the lower river was made in the report. It was recognized that bulk cargoes, in particular, petroleum and iron ore, would increase as industry increased their requirements along the Delaware River. Table I shows the waterborne commerce by years from 1940 through 1966 for the Delaware River from Trenton to the Sea. Waterborne commerce in 1966 reached a total of 105.2 million tons or 60% increase over the 1953 figures used in the District's report of 1955.

IV VESSEL TRAFFIC

The District's report of 1955 presents statistics on the number of vessel trips by draft for the years 1948 through 1953 inclusive. Table II and Table III contain detailed breakdown of vessel trips by draft for the projects Delaware River, Phila., to the Sea and Delaware River, Philadelphia to Trenton. Taking 1953, the last year used in the statistical information, the total vessel traffic over 20 feet in draft amounted to 6,783 trips. While numerical projection was not included in the report, general statements indicated increases could be expected in the number of vessel trips. The report of 1955 did state that vessels in excess of 32 foot drafts could be expected to increase from 771 in 1953 to an average of 2120 annual trips over the life of the project, estimated at 50 years.

The number of vessels in the category of 32 feet and over in draft had shown dramatic increases for the period of the report; they had gone from 102 trips in 1948 to 771 trips in 1953. Table IV contains the number of trips by draft of vessels using the Philadelphia to the Sea project for the years 1954 to 1966. Table V contains similar information for the project Philadelphia to Trenton. Total traffic for over 20 foot drafts has gone up by some 20% to 8,174 trips in 1966. However, the vessel trips over 32 foot in draft have more than doubled to 1,638 trips.

V ANCHORAGE USAGE

Previously authorized anchorages at Marcus Hook and Mantua Creek, with depths of 37 feet, were considered capable of accommodating vessels having a maximum draft of 32 feet and lengths of 500 feet. It was considered that vessels exceeding this draft and length would be unable to anchor, with safety, in either of these two anchorages or in any designated anchorage area upstream of Delaware Bay. As previously indicated, vessel trips for ships larger than 32 foot in draft had already reached 771 in 1953. Hazardous navigation conditions were cited as a primary need for larger anchorages. It was considered that navigation became increasingly dangerous when horizontal visibility reduced below ¾ of a mile. Reports by shipping interests claimed delays due to lack of adequate anchorage facilities for deep draft vessels and congestion of the existing anchorages. The quarantine area at Marcus Hook Anchorage was noted to be a particularly acute congestion problem due to its use as a quarantine tieup area. Sampling of the vessels anchoring at Marcus Hook, during the time the report of 1955 was prepared, for a 92 day period, indicated that a total of 435 ships used the anchorage at an average of approximately 5 per day. The anchorage was reported full on 22 days or a total of 86 hours during this sampling period. On an annual basis, it was estimated, there would be 14 days per year when the anchorage would be full and there would be an estimated 70 ships delayed waiting for space in Marcus Hook Anchorage. Similarly, the use of Mantua Creek Anchorage, as detemined from Coast Guard reports was estimated at 3.75 ships per day. There were 6 days per year when the anchorage was full and it was estimated that 23 ships per year would be delayed awaiting space at Mantua Creek Anchorage.

To verify current usage at the anchorage, a check was made during the first half of 1968 which indicated that the average usage was something on the order of 1/3 of a vessel in Marcus Hook Anchorage, with the longest vessel being 777 feet 9 inches in length. This is certainly a far different usage pattern than did exist in 1953 or was projected at that time. The authorized enlargement of Marcus Hook Anchorage was contemplated to accommodate six vessels of 800 foot in length. A check in 1968 of Mantua Creek Anchorage indicates that the average usage of 3.75

ships on a daily basis in 1953 had decreased to 1.58 ships daily, with a maximum vessel length of 829 feet 8 inches. It is interesting to note that even without enlargement that vessels in excess of 800 feet are *now* using Mantua Creek Anchorage. Contemplated enlargement of Mantua Creek Anchorage was to accommodate five ships of up to 800 feet in length. The entire improvement contemplated in the report would provide a series of four anchorages 40 feet deep and 2300 feet wide spaced at distances of 9 to 16 miles apart in the 55 mile reach of the Delaware River from Bombay Hook Point to the mouth of the Schuylkill River. These anchorages would accommodate a total of 16 ships with lengths of from 600 to 800 feet. A significant factor in usage of the Marcus Hook Anchorage in recent years has been a modernization in quarantine procedures wherein they are now performed at dockside rather than in anchorages which was the practice when the original anchorage study was made.

VI ACCIDENT EXPERIENCE

The frequency of accidental collisions that existed in 1954 was calculated at 0.4 accidents per year. This calculation was based on the fact that there were two collisions during the period 1950 to 1954, producing the average of 0.4 accidents per year. An average of 690 trips per year, by deep draft vessels during this same time period was reported. The projected increase in average annual traffic of deep draft vessels, that is ore carriers and tankers, for the life of this project was estimated at 1430 additional trips annually. This produces a total of 2120 trips annually. It was estimated that the accident frequency rate would double when the traffic would triple resulting in an accident rate of 0.8 for the original 690 trips or 2.46 accidents per year, for the prospective total of 2120 trips. Monetarily, this was estimated to amount to $1,761,000 annually. This again was based on the monetary loss due to the two collisions during the time period 1950 to 1954, when the average accident cost was $716,000. During this same time period from 1950 to 1954, Coast Guard records indicated 47 groundings in the Delaware River between Philadelphia and the Sea. Analysis of these records indicated that eight groundings could be attributed to the lack of suitable anchorages. Total damage to the vessels during the period 1950 to 1954 was estimated at $180,000. Total losses to the vessels due to the grounding damage during this same period was estimated at $326,000. The portion attributable to the lack of suitable anchorage space was estimated at approximately $55,500 or $11,100 annually. This again was projected in the same ratio as the collisions and resulted in an estimated average annual loss of $68,200. A review of Coast Guard records for the period 1953 to 1967 indicates that the most optimistic level of preventable accidents and delays would have been in the order of something less than $250,000 annually. Table IV contains the yearly experience and a summary

of this information as extracted from the U.S. Coast Guard records. It should be noted that this indicates a lesser magnitude than existed in 1953, despite increased exposure of more than double the traffic.

VII BENEFIT—COST RATIO

The estimated cost of enlargement of Mantua Creek and Marcus Hook Anchorage and the construction of Reedy Point and Deepwater Point Anchorages, as contained in the report of 1955, totalled $25,427,600. Individually, $7,522,000 was estimated for Mantua Creek, $10,796,000 for Marcus Hook, $2,846,000 for Reedy Point and $3,382,000 for Deepwater Point Anchorages. Additional costs were $600 for changes in navigational aids and $980,000 for pipeline relocations. Benefits were based on the estimated preventable accidents, groundings and delays being experienced by navigation. As previously indicated, the average annual losses amounted to $1,872,000. This was reduced to $1,498,000 based on the assumption that only 80% would be eliminated as an estimate of future benefits to be associated with the anchorage improvement. This resulted in a benefit to cost ratio of 1.03 to 1. Since completion of the 1955 report, the cost of the improvements have been escalated to 29.6 million dollars. Using the preventable accident figure as developed from Coast Guard records and 1957 through 1967, wherein accident delays have been calculated at approximately $250,000 annually, a benefit to cost ratio of 0.15 results for this project.

VIII DISCUSSIONS WITH NAVIGATION INTERESTS

Appendix A includes additional data on a proposed deepwater terminal as presented to the Joint Executive Committee for the Improvement and Development of the Philadelphia Port Area on 27 February 1969. Appendix A includes presentations made by Colonel James A. Johnson, District Engineer and Mr. Carl Cable, Assistant Chief, Operations Division, on the Delaware River, Philadelphia to the Sea project and the anchorages included therein

As a follow up to Colonel Johnson's request for the factual data the Philadelphia Marine Trade Association, a member of the Joint Executive Committee for the Improvement and Development of the Philadelphia Port Area, undertook to obtain information relative to delays to ships due to inadequate anchorages (See Appendix A for copy of their notice of 11 March 1969). Only two responses were received. Both shipping firms indicated they had no problem.

IX CONCLUSIONS

This sub-study has developed the rationale presented in the study of 1955 for improving the Federally authorized anchorages at Marcus Hook and Mantua Creek and construction of new anchorages at Reedy Point and Deepwater Point. Each significant factor contained in this report has been reviewed and updated to present time. The following conclusions are drawn from this updating process.

a. The traffic generated by large vessels, namely, tankers and ore carriers has gone up as projected. Vessel trips for those in excess of 32-foot draft have increased from 771 in 1953 to 1,638 in 1966. The average annual traffic over the life of the project was projected as 2,120 trips annually. The overall increase for vessels in excess of 20 foot draft, which mounted to 6,783 trips in 1953, has gone up by some 20% to 8,174 trips in 1966.

b. Total commerce on the Delaware River, Phila. to the Sea has also increased from 66.2 million tons to 105.2 million tons. A 60% increase in this same time frame.

c. The projected increase in accident experience in the basic report has not come about and in fact has dropped below the level of 1953. Factors which have contributed to the decline in accidents are considered to be the implementation and widespread use of radar and bridge-to-bridge radio communications between the pilots, which has greatly increased navigability and safety during questionable weather conditions.

d. Use of presently available improved anchorages has declined substantially since the 1955 study period. It has become increasingly evident that vessels, with drafts in excess of 36 feet, schedule operations to come up this river on a rising tide and direct to dockside even though anchoring in Delaware Bay is required. The present practice of quarantine inspection at dockside rather than while the vessel is in anchorage has reduced anchorage requirements.

e. Shipping interests in response to request have not furnished any factual data, records of economic loss by delay or accidents because of limitations of present anchorage size.

X RECOMMENDATIONS

It is recommended that no additional work connected with the anchorage improvements authorized under Public Law 85-500, 85th Congress S3910, 3 July 1958, be undertaken until such time as need is demonstrated. Changes in vessel size, operating procedures and improvements in navigational assistance systems for the navigators has substantially reduced the requirements for additional and larger

anchorages in the Delaware River project, Philadelphia to the Sea. Proposals for further improvements to navigational systems in the Delaware River and the proposed deepwater terminal in Delaware Bay and offshore mooring systems for larger tankers could have a significant affect on anchorage usage in the future.

In the event need is demonstrated for increased anchorage facilities in the Delaware River, at some date in the future, it is recommended that alternatives to enlargement of existing facilities be considered. Such alternatives might include mooring dolphins, provision of bow and stem anchors on ships to be anchored to limit swing of vessel and thereby increase present anchorage capacity, and some convincing evidence why holding of large vessels in lower Delaware Bay, rather than using upstream anchorages is objectionable or with economic loss.

APPENDIX A

PRESENTATION AT
JEC MEETING
27 FEBRUARY 1969

TABLE OF CONTENTS

PRESENTATION BY COLONEL JAMES A. JOHNSON,
PHILADELPHIA DISTRICT ENGINEER,
JEC MEETING, 27 FEB 69.

I am pleased to meet with you today. I am also pleased that Mr. Jackson arranged this meeting because I need input from all interested parties in order to do my job. Much of my job is making recommendations on what best serves the public interest within the restraints of what is justifiable and achievable. This is a more difficult responsibility to fulfill than merely being in favor of everything that it would be nice to have. It requires evaluation of proposals and desires, justification for expenditures, and frequently an assessment of relative importance.

With that as a background I want to recognize that this meeting today is structured to discuss primarily 5 items, or projects, which are of significant interest to the navigation community. These are:

1. C & D Canal improvement.
2. Delaware River maintenance dredging between Philadelphia and the Fairless works.
3. Advance maintenance in Delaware River to assure 40 feet depths at all times.
4. Anchorage improvement project.
5. Delaware River dimension study, to include Deepwater Terminal in Delaware Bay.

Each one of these items have their particular proponents, each one of these items have their particular benefits; and each one of these items have their particular costs. To this end Mr. Cable of my staff will make a presentation on the first four items and Mr. Sivard will make a presentation on the Delaware River Dimension Study and the Delaware Bay Anchorage.

The purpose of their presentations is to give you in capsule form the pertinent information and data which we have on each of these items. We hope to then obtain from you the further information you may have on the merits and advantages of each of these items. Options are valuable but hard statistics and economic data are best. There is no substitute for hard economic projections to establish benefit cost ratios for Congressional Action. Such data delivered to us in written form on the stationery of the ultimate beneficiary of the project is the best supporting evidence we can get.

I will now turn this over to Mr. Cable and Mr. Sivard. I will summarize their presentations when they are completed. After that I presume Mr. Jackson will desire discussion from the floor. At this time I present Mr. Cable of my staff.

(Colonel Johnson's summary emphasized the importance of submitting, in writing, statistical data bearing on the projects discussed. Results of this plea are presented later in this appendix.)

DELAWARE RIVER, PHILADELPHIA TO THE SEA

Presented by

Carl Cable, Assistant Chief Operations Division

JEC MEETING 27 FEB. 1969

In colonial times the ports of Philadelphia looked like this. The channel at that time was 17 feet deep. (Vugraph)

Since then the ports of Philadelphia have grown until today they are the leading import center of the United States and the largest oil refining center along the East Coast.

The channel too has grown – or, more properly – been made deeper and wider. Today we have an authorized channel 40 feet deep all the way from Deepwater in Delaware Bay to Newbold Island.

As part of the contract we had for the upper Delaware River, maintenance dredging in the 40-foot channel in Philadelphia harbor was completed in September 1968. Approximately 80,000 cubic yards were removed at a cost of $92,500.

In maintaining this channel we use three dredges, the Comber, Goethals and Essayons. The Essayons, largest of all Corps dredges and one of the largest dredges in the world, comes to the Philadelphia area only occasionally, and when she does she usually works in the Delaware Bay reaches of the channel. Most of her time is spent in Norfolk and New York harbor. The other two dredges however – the Comber and the Goethals – can both be seen on the Delaware River. Both of these dredges have been modified to provide for positive retention and removal of dredged material. This system – known as direct pumpout – is a development of this district. Since we introduced this system, our maintenance requirements in this project have been reduced from 22 to 10 hopper dredge months.

Maintenance dredging by the government hopper dredge Comber in the 40-foot project channel has resulted in removal of approximately 4,500,000 cubic yards during the first two quarters of this fiscal year. We have the Comber working in the C&D Canal removing serious shoaling in the land cut from St. Georges to the state line. This work will be completed about 1 March 1969 and the dredge will then be assigned to Marcus Hook Range.

Marcus Hook Range presents us with two problems. First, it represents the most severe shoaling area in the Delaware River. Shoaling here averages about a foot a month. We have experienced a dramatic increase (700%) since the Marcus Hook Anchorage enlargement. We have to assign the hopper dredge to this area several times a year and still cannot maintain full project depth. Frequently, the channel shoals to as little as 34 feet between assignments. Secondly, our ability to provide better depths on Marcus Hook Range is seriously hampered by existing rock formations along this range.

During the initial construction of the 40 foot channel, rock was only removed to 40 feet. This does not provide a cushion, or as we call it "advance maintenance," for accommodating any shoaling and in fact precludes attaining a full project depth while dredging.

We have had to go back and clean up some rock pinnacles extending about 40 feet along this stretch of the river – pinnacles which have often been located by a deep draft vessel striking the obstruction. We have been working since last November on the last known pinnicles along Marcus Hook Range.

We have developed and submitted to the office of the Chief of Engineers a program for developing a capability for providing project depth in this project. This program would accomplish clearing of rock areas and rapidly shoaling areas to a depth of at least 44 feet and the remaining channel areas to a depth of 42 feet. Total cost of this proposed work is estimated at $31 million, the phase to provide 44 feet costing $16 million and the remaining work $15 million. The second phase of this program may lack justification as an increment by itself inasmuch as the area of the channel covered has a full 40 foot depth a predominant amount of time under present conditions. We presented this program on a five year schedule, the first year being $2 million. No funds are presently included in the President's budget for FY 1970 for this work. The President's budget reflects $5 million for this project in FY 1970; our capability on this project is $7.61 million including $2 million for initiating the rock removal in the advance maintenance program presented above. The work proposed to be accomplished with this capability in addition to initiation of rock removal on Marcus Hook Range by contract is removal of shoals in Philadelphia Harbor by contract, and added work in Marcus Hook Anchorage by contract.

DELAWARE RIVER ANCHORAGES

Presented by

Carl Cable, Assistant Chief, Operations Division

JEC MEETING, 27 FEB. 69

I would like to review for you the authorized improvement program to enlarge two Delaware River Anchorages and to create two new Anchorages. These Anchorages are shown on the Vugraph (Explain each Anchorage and the improvement to be made at Mantua Creek, Marcus Hook, Deepwater, and Reedy Point).

Let's take a look at some of the factors considered in reporting on this proposed improvement. Of great interest was the increase in traffic, particularly the Deep Draft Vessels, and the projected pattern for traffic in the Delaware River. In 1953, the year used as base in the report, the total vessel traffic over 20' drafts amounted to 6783 trips. While no numerical projection was included in the report, general statements indicated increases could be expected. The report did state that, vessels in excess of 32' draft could be expected to increase from 771' in 1953 to an average of 2120 annual trips over the life of the project (50 years). What has actually happened since 1953? Total traffic, over 20' drafts, has gone up by 20% to 8174 trips, while trips for vessels over 32' draft has more than doubled to 1638 trips. Commerce has also increased from 66.2 million tons to 105.2 million tons (A 60% increase) in this same time frame. All of this data seems to be saying everything we said is proceeding according to plan. But let's look at the vital statistics for this improvement project. The enlargement of Marcus Hook Anchorage was completed in 1966 at a cost of $8.5 million. This improvement is intended to accommodate six ships of up to 800' length. Rapid shoaling has prevented its full use. In fact the buoys to mark the 900' extension to the eastward have not been moved by the Coast Guard. Restoration of the improved portion of the Anchorage would require several million dollars of maintenance funds. By way of comparison, Marcus Hook Anchorage represents 720 acres of parking area for vessels. This is big enough to hold the entire East-West Runway at Philadelphia International Airport with room to spare.

What usage is Marcus Hook Anchorage averaging? When the report was prepared in 1953 the average usage was 4.75 ships of up to 500 feet in length. The Anchorage was designed to hold five ships. The report projected a requirement for six ships of up to 800 feet in length. A check of records for the first half of 1968 indicate that the average occupancy was something on the order of one-third of a ship with the longest vessel anchored being 777'9" in length. This is certainly a drastically different usage pattern than did exist in 1953 or was projected at that time. We find the same pattern existing for Mantua Creek. In 1953, average usage was 3.75 ships daily, projection was for five ships of up to 800 feet in length. A check in 1968 indicated actual usage of the Anchorage had decreased to 1.58 ships daily with maximum vessel length of 829'8".

Even though, the benefit cost ratio was deemed not the primary factor in justifying this improvement. Let's take a look at what has happened in this area for this project. We customarily use the ratio of annual benefits attributed to a project vs. the annual costs or charges to determine the worth of a project. For this project the major tangible benefits are reduction in damage and delay. The accident experience rate at the time of the report was determined to be 0.4 for the period 1950–1954. This was based on two major accidents during this period. It was estimated that the rate would double while traffic would treble, resulting in a new rate of 0.8 for those trips and projected to 2.46 for the anticipated trips. Thus annual losses of $304,475 in 1953 would be eliminated by the proposed improvements, projected this became $1,498,000 ($1,872,000 x .80% eliminated by anchorages). This gave a benefit cost ratio of 1.03. What has happened? A review of coast guard records for the period 1953–1967 indicates that the most optimistic level of preventable accidents and delays would have been in the order of something less than $300,000. A lesser magnitude then existed in 1953, despite increased exposure of more than double the traffic. What with increased cost of providing the improvements desired (now estimated at $29.6 million vs. $24.5 in report) a benefit cost ratio of considerably less than unity (actually 0.15) now results for this project.

One problem that was recognized in 1953 and which still exists today is the lack of adequate anchorage facilities in the Philadelphia Harbor Area. The nature of the presently authorized anchorage project does not appear to meet navigation requirements.

All of this leads to the question "what kind of anchorage facilities are required in the Delaware River?" We have a $29.6 million program to create parking space for 16 ships of up to 800' in length. Is this the answer? We need your expert advice in this matter.

DELAWARE RIVER CHANNEL DIMENSION STUDY

Presented by

Frank Sivard, Assistant Chief, Planning and Reports Br.

JEC MEETING, 27 FEB. 1969

The Delaware River channel dimensions study is being made in response to a resolution adopted by the Senate Committee on public works back in 1954. The resolution actually called for a study to determine whether any modifications should be made in the existing channel dimensions and anchorage areas.

At the request of local maritime interests, we gave top priority to the anchorage problem, and submitted a report in 1955 recommending new anchorages at Reedy Point and Deepwater Point, and enlarged anchorages at Marcus Hook and Mantua Creek. The recommendations were adopted by Congress in 1958. These are the anchorages which Mr. Cable discussed earlier.

We initiated the study of the channel dimensions problem in 1956 with a public hearing at which Maritime interests expressed their views on the improvements needed. They requested that the channel be deepened to 50 feet (mean low water) from Allegheny Avenue to the sea and that the channel be widened from 1,000 to 2,000, as dictated by conditions in each range. There were no funds allocated to the study during fiscal years 1958 through 1963. Funds were again made available in fiscal year 1964. When renewed intensive pressure by local interests suggested the urgency of the matter.

Since many of the factors bearing upon the study changed after its initiation, funds allocated in 1964 were used to make a feasibility study to determine if there were any justification for making a full-scale detailed study. The feasibility study, completed in June 1964, considered incremental channel depths of 40, 45 and 50 feet, with widths ranging from 1,000 and 2,000 feet as requested by local interests. The study consisted generally of preliminary estimates of costs and estimates of transportation savings that would accrue to the port from the use of larger tankers to transport crude to the Delaware River refineries. It was estimated that we would have to remove about 181.2 million cubic yards of common material and 7.7 million cubic yards of rock to achieve a 45-foot channel, and about 315.7 million cubic yards of common material and 15.5 million cubic yards of rock for a 50-foot channel. This compares to the total of about 863 million cubic yards of material that we have removed from the river since we first started dredging in it, about 100 years ago. Total first costs for a 45-foot channel, at 1964 prices, were estimated to be $298,000,000, and first costs of a 50-foot channel were $562,000,000. It must be noted that those estimates are very rough, and were based on the assumption that suitable disposal areas would be available and that disposal would be accomplished at a nominal cost.

On the basis, the unit costs for dredging and disposal, at 1964 prices, were estimated to be about 90 cents per yard for pipeline dredging and 50 cents per card for Hopper dredging. It would cost about $8 per yard to remove rock for the 45-foot channel, and about $6.50 per yard for a 50-foot channel.

We estimated that it would take from 5 to 10 years to dredge a 45-foot channel, and 10 to 20 years for a 50-foot channel, depending upon the funding schedule and the availability of plant. As a matter of interest, we recently went through the exercise of updating the 1964 estimates to reflect 1969 prices, and the current Federal Interest Rate of 4-5/8%. On that basis, the price tag on a 45-foot channel jumped to 387 million dollars, and the 50-foot channel to 780 million dollars.

Benefits expected from the proposed modification were assumed to be the differences in total costs of transporting crude by using a 45-foot or 50-foot channel rather than the existing 40-foot channel. The average annual savings by using a 45-foot channel were estimated to be $13,400,000 while savings of a 50-foot channel amounted to $25,000,000. These produced benefit to cost ratios, at 1964 price levels, of 1.1 to 1 for a channel either 45 or 50 feet deep, and provided a basis for continuing with the detailed studies of the proposed modifications.

Before resuming the detailed studies, we held another public hearing, in June 1965, to ascertain if the views or desires of local interests had changed during the 9 years since the initial hearing. Apparently they had not, because they requested the same modifications as they had in 1956.

In resuming the detailed study, it became apparent that many and complex factors would have a significant bearing upon the justification of a deeper and wider channel from Philadelphia to the sea. Some of the more significant among these are:

A. Projections of future commerce: The economics of a deeper channel still depend principally upon the amount of crude to be brought into the Philadelphia refineries. However, future ore demands are also a factor. Volume projections depend on any number of things; i.e. capacity of refineries, demand for petroleum, future power technology, future ore demands, etc.

B. Effects of the oil import restrictions: President Nixon has recently assumed personal responsibility previously assigned to the Department of the Interior for regulation of the quantity of crude petroleum that can be imported. Future developments concerning these quotas may have a significant effect on future volumes coming into Delaware River since most crude now entering the area is foreign.

C. Vessel Sizes: The phenomenal increase in the size of tankers has a most significant effect on the economics of modifying the channel dimensions of Delaware River. In 1956, when the first public hearing on this study was held, a 75,000 DWT tanker was considered to be mammoth. On that basis, it appeared that if the channel in Delaware River were 50 feet deep all of the prospective crude brought through the Delaware could be delivered directly from port of origin to the refineries on the larger vessels. However, tankers upwards of 300,000 DWT are now in operation. It is obvious that these great vessels, with drafts in the 70-foot range, will never transit the Delaware, however, they will exert a great influence on the economics of the Delaware River channel. The economy of their operation compels serious consideration of developing facilities that will permit their use in delivering crude to Delaware River refineries.

D. Depths at Ports of Origin: One of the most significant factors affecting the size of tankers using the Delaware is the channel depth. Existing depths at most of the major foreign oil shipping ports are greater than in Delaware River. It is apparent that shallower depths in the Delaware are restricting the size of vessels in Philadelphia foreign crude trade.

E. Spoil Disposal: The spoil disposal problem is a major obstacle in attaining such a major improvement as the 45 or 50 foot channel. The cost estimates made and the benefit cost ratios quoted are on the assumption that spoil disposal areas in reasonably close proximity of the digging will generally be available. This assumption loses validity as time moves on and the geography surrounding the river becomes more developed. There are increasingly strong objections by fish and wildlife interests to the use of additional marsh areas along the estuary for disposal, the opposition to the acquisition of fast land for spoil disposal is equally adamant. There is only limited potential for construction of in river disposal areas anywhere in the Delaware River above the Delaware Memorial Bridge. Those which show some potential are needed for orderly maintenance of presently constructed channel project.

F. Salinity Intrusion: Preliminary studies have indicated probable adverse effects through salt water intrusion up Delaware River if a large scale dredging operation is performed. There is concern about the advance of salinity to the Philadelphia water supply intake, and the effect that a change in salinity regimen of the estuary might have on marine life, or on aquifers that are sources of water supply for Delaware and Southern New Jersey.

G. Subsurface Conditions: Detailed and very costly investigations are necessary to determine the exact location and extent of the various classifications of material which would have to be removed if we are to deepen the channel.

As our studies progressed, the size of tankers continued to grow, and it became evident that the 50-foot channel which had been suggested would be grossly inadequate for the tankers which will dominate the foreign crude picture in the future. As a matter of simple logic, it is obvious that we can never deepen the channel to Philadelphia enough to accommodate those monsters. This gives rise to serious consideration of an altemate means of accommodating them. The most logical solution appears to be a facility in the deep waters of Lower Delaware Bay.

The possibility of constructing a Terminal Facility in Lower Delaware Bay, with pipelines to the refineries, has intrigued petroleum interests for many years. The proposition has been studied by the industry several times; and repeatedly discarded as being neither practical nor economically feasible, either on an individual company or an industry basis. However, the proposal never really perished, and it is now being actively considered by the Delaware Bay Transportation, Company, a consortium of 11 major Oil Companies which has developed a plan, and is now considering the feasibility of constructing the facility. The idea of a group of companies with common interests joining forces to accomplish a task which would be impossible for one is not a new one. It has been used in Europe for many years—and just a few weeks ago Life Magazine carried an article about a group of Oil Companies forming a consortium to transport crude oil from the Alaskan Alopes to the refineries.

In general, the plans are for a terminal in Lower Delaware Bay, Storage Facility and alternate schemes for transporting crude from the storage facility to the refineries by pipeline or barge. The terminal would consist of a marginal wharf, located about six miles offshore near Big Stone Beach, Delaware, to accommodate 250,000 DWT Tankers.

I see that Bob Howe, President of the Delaware Bay Transportation Company, is here today. I'm sure he would be pleased to answer questions regarding the consortium and its plans.

The DBTC Studies have been premised upon a facility adequate to accommodate 250,000 DWT Tankers, having a loaded summer salt-water draft of 65 feet. A channel depth of 72 feet has been assumed as the safe minimum for those vessels. Although there are natural depths in excess of 72 feet over most of the area for the proposed channel and turning basin, there are some places where the controlling depth is about 60 feet. Accordingly, we have been requested by DBTC to consider the feasibility of the Federal Government constructing and maintaining a 72-foot deep channel and turning basin.

Because of the significant impact the Deepwater Facility would have upon the economics of deepening the Channel from Philadelphia to the sea, we have placed emphasis on completing our studies of the Deepwater Facility. We have coordinated closely with the DBTC, and plan to complete our preliminary analysis by about 1 July of this year.

We have determined, from detailed surveys, the quantities of material that would have to be dredged to provide channels of various depths. This slide shows some of that information. Note that about 10.4 million cubic yards would have to be removed to provide a depth of 72 feet. That is a much more attractive figure than the 330 million cubic yards that would have to be removed to provide a 50-foot channel to Philadelphia, and it would most certainly minimize the disposal problem.

We plan to continue to commit our study effort to the Deepwater Facility. If the preliminary analysis indicates that it appears to be a sound project, we plan to request authority to prepare an interim report on that subject. If that study produces a favorable recommendation, we will then be able to make a more realistic evaluation of the benefits which might accrue from a deeper channel to Philadelphia. It may well be evident very early in that investigation that there would not be sufficient Deep-Draft traffic upstream of the Deepwater Facility to justify a deeper channel. If that is the case, we will discontinue detailed studies and submit an unfavorable recommendation. On the other hand, if it appears likely that a deeper channel might be justified, we will continue with detailed studies, including all the factors I mentioned earlier.

The estimated total cost of the study, including the 1955 report on the anchorages, is $566,000. Of that amount, we have received $341,000, through fiscal year 69. There is another $45,000 in the president's budget for FY 70, which leaves a balance of $180,000 for future funding. Our present schedule calls for completing the study in fiscal year 1972.

PHILADELPHIA MARINE TRADE ASSOCIATION

SUITE 600, LAFAYETTE BUILDING
FIFTH & CHESTNUT STS., PHILADELPHIA, PA. 19106
WA 5-0438 • WA 5-3668

Circular No. 28-69 March 11, 1969

TO: SHIP AGENTS AND SHIP OPERATORS
SECTION COMMITTEES

Gentlemen:

Availability of Anchorages

At the last Monthly Meeting of the Ship Agents and Ship Operators Section Committees, PMTA was requested to assist in obtaining certain information on behalf of the U. S. Army Corps of Engineers with respect to anchorages in the Port of Philadelphia.

Specifically, members are asked to indicate the number of ships that have been delayed at the breakwater because of inadequate anchorages with respect to depth and width in the harbor area, the total number of hours involved and the cost of their delays. It would also be appropriate to mention particular safety hazards. For example, situations where deep loaded ships proceed up the channel on a flood-tide and the problems created in such instances by unavailability of the berth, or a sudden change in the weather.

The above information should cover the Calendar Year 1968 and should be forwarded on corporated letterhead to the District Engineer, U. S. Army Corps of Engineers with copies to PMTA and the Joint Executive Committee.

Yours very truly,

ALFRED CORRY
EXECUTIVE SECRETARY

cc: Joint Executive Committee
Lewis Caccese, Chief of Operations
Phila. District, U. S. Army Corps of Engineers

NORTON, LILLY & CO., INC.
201 BOURSE BUILDING, PHILADELPHIA, PA. 19106

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March 14, 1969

Mr. Lewis Caccese, Chief of Operations
District Engineer
U. S. Army Corps of Engineers
2nd & Chestnut Streets
Philadelphia, Penna. 19106

Dear Sir:

In compliance with the Philadelphia Marine Trade Association's Circular No. 28-69, this is to advise you that this Company during the calendar year of 1968 had no vessels delayed at the breakwater because of inadequate anchorages in the Philadelphia area.

Very truly yours,

NORTON, LILLY & CO., INC.

GCB:EA

c.c. Joint Executive Committee,
Phila. Maritime Society
Phila. Marine Trade Association

March 14, 1969

Phila. Marine Trade Association
Suite 600, Lafayette Building
5th & Chestnut Streets
Phila., Pa. 19106

Gentlemen:

With reference to your letter dated March 11, 1969, Circular No. 28-69 to Ship Agents and Ship Operators, with regards to Availability of Anchorages, for your guidance, during the calendar year 1968 Furness, Withy, as Agents, did not have any vessels delayed at the breakwater due to inadequate anchorages with respect to depth and width in the Philadelphia Harbor area.

Yours very truly,
Furness, Withy & Co., Ltd.

C. S. Donohue,
Assistant Manager

CSD/ems

c.c. District Engineer
U.S. Army Corps of Engineers
U.S. Custom House
2nd & Chestnut Streets
Phila., Pa.

LONG RANGE SPOIL DISPOSAL STUDY

DELAWARE RIVER ANCHORAGES

U.S. ARMY ENGINEER DISTRICT PHILADELPHIA

PLATE 1

TABLE I

COMMERCE IN SHORT TONS

DELAWARE RIVER, PHILADELPHIA TO TRENTON AND PHILADELPHIA TO THE SEA

Calendar Year	Allegheny Avenue Phila. to the Sea	Allegheny Avenue Phila. to Trenton	Total
1940	27,657,748	4,410,253	32,068,001
1941	30,045,509	5,971,665	36,017,174
1942	16,803,443	5,778,460	22,581,903
1943	18,674,869	4,992,304	23,667,173
1944	27,330,544	4,240,742	31,771,286
1945	29,557,581	4,261,109	33,818,690
1946	37,151,175	5,093,376	42,244,551
1947	41,926,565	5,832,313	47,758,878
1948	42,375,306	7,218,245	49,593,551
1949	39,637,740	5,901,449	45,539,189
1950	52,601,768	7,085,759	59,687,527
1951	56,848,418	7,508,238	64,356,656
1952	55,331,473	6,949,933	62,281,406
1953	58,556,571	7,525,881	66,182,452
1954	60,848,511	9,828,473	70,676,984
1955	67,675,339	11,089,837	78,765,176
1956	78,609,073	11,435,995	90,045,068
1957	79,557,327	13,631,418	93,188,745
1958	74,182,536	12,808,225	86,990,761
1959	80,160,188	12,955,632	93,115,820
1960	77,345,346	14,918,744	92,264,090
1961	73,792,680	13,841,839	87,634,519
1962	81,500,328	17,244,231	98,744,559
1963	79,527,314	16,449,237	95,976,551
1964	80,242,982	21,529,659	101,772,641
1965	82,176,213	20,442,541	102,618,754
1966	86,036,326	19,156,520	105,192,846

TABLE II

TRIPS AND DRAFTS OF VESSELS ARRIVING AND DEPARTING DELAWARE RIVER, PHILADELPHIA TO THE SEA

Actual Draft in Feet

Calendar Year	40 and Over	39	38	37	36	35	34	33	32	31	30	Local Total	29 or less	Total all Drafts
1954														
Upbound	–	–	–	–	18	172	191	202	366	643	218		161,050	162,860
Downbound	–	–	–	–	–	–	–	5	111	169	80		158,257	162,860
TOTAL	–	–	–	–	18	172	191	207	477	812	298	9443	319,307	325,720
1955														
Upbound	–	–	–	4	62	220	242	178	299	599	194		161,764	163,562
Downbound	–	–	–	–	–	–	1	2	39	80	43		163,397	163,562
TOTAL	–	–	–	4	62	220	243	180	338	679	237	16232	325,161	327,124
1956														
Upbound	–	–	–	9	57	260	250	203	350	640	217		190,537	192,523
Downbound	–	–	–	–	–	–	2	4	43	89	69		192,373	192,580
TOTAL	–	–	–	9	57	260	252	207	393	729	286	22438	382,910	385,103
1957														
Upbound	6	6	10	33	69	221	276	291	635	775	305		184,507	187,138
Downbound	–	–	–	–	1	14	15	21	95	260	214		186,484	187,604
TOTAL	6	6	10	33	70	235	291	312	730	1035	519	25529	371,491	374,742
1958														
Upbound	16	5	18	31	71	243	264	220	340	521	203		148,336	150,268
Downbound	–	1	–	–	1	4	8	6	35	250	140		149,577	150,022
TOTAL	16	6	18	31	72	247	272	226	375	771	343	21412	297,913	300,290
1959														
Upbound	–	13	31	52	121	318	275	234	399	563	150		98,133	100,294
Downbound	–	–	–	–	–	1	3	6	12	217	102		100,179	100,520
TOTAL	–	13	31	52	121	319	278	240	411	780	252	20065	198,312	200,814
1960														
Upbound	8	25	39	50	128	291	217	256	429	531	176		130,867	133,017
Downbound	–	–	–	–	1	1	5	9	54	185	82		132,926	133,263
TOTAL	8	25	39	50	129	292	222	265	483	716	258	19821	263,793	266,270
1961														
Upbound	11	25	72	102	193	270	205	200	265	420	137		60,559	62,459
Downbound	1	1	–	3	7	12	13	21	69	188	87		61,855	62,257
TOTAL	12	26	72	105	200	282	218	221	334	608	224	15540	122,414	124,716
1962														
Upbound	11	54	125	156	186	330	204	182	250	303	166		33,729	35,696
Downbound	–	–	–	–	1	3	17	26	51	135	211		34,885	35,329
TOTAL	11	54	125	156	187	333	221	208	301	438	377	187825	68,614	71,025
1963														
Upbound	14	105	147	142	222	267	162	152	192	257	116		26,380	28,156
Downbound	–	–	1	–	5	3	16	30	100	213	115		27,746	28,229
TOTAL	14	105	148	142	227	270	178	182	292	470	231	92048	54,126	56,385
1964														
Upbound	31	193	172	131	249	200	186	167	136	157	100		28,714	30,436
Downbound	–	1	1	1	4	5	8	43	134	149	94		29,998	30,438
TOTAL	31	194	173	132	251	205	194	210	270	306	194	84601	58,712	60,874

TABLE II (CONT'D.)

TRIPS AND DRAFTS OF VESSELS ARRIVING AND DEPARTING DELAWARE RIVER, PHILADELPHIA TO THE SEA

Actual Draft in Feet

Calendar Year	40 and Over	39	38	37	36	35	34	33	32	31	30	Local Total	29 or Less	T D
1965														
Upbound	59	211	174	136	224	226	151	108	114	116	68		24,933	26
Downbound	–	2	1	2	4	13	41	52	103	114	93		21,496	21
TOTAL	59	213	175	138	228	249	192	160	213	230	161	81779	46,429	48
1966														
Upbound	107	254	169	123	206	202	140	75	112	107	91		34,368	35
Downbound	1	2	1	1	–	15	60	61	109	90	91		35,079	35
TOTAL	108	256	170	124	206	217	200	136	221	197	182	106177	69,447	71

SUMMARY

	Year											
	1954		1955		1956		1957		1958		1959	
	Actual Draft in Feet											
	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	
Upbound	583	1227	706	1092	779	1207	912	1715	868	1064	1049	1
Downbound	5	360	3	162	6	201	51	569	20	425	10	
TOTAL	588	1587	709	1254	785	1408	963	2284	888	1489	1059	1

	Year													
	1960		1961		1962		1963		1964		1965		1966	
	Actual Draft in Feet													
	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	
Upbound	1014	1136	1078	822	1248	719	1211	565	1329	393	1289	298	1276	2
Downbound	16	321	58	344	47	397	55	428	63	377	115	310	141	1
TOTAL	1030	1457	1136	1166	1295	1116	1266	993	1392	770	1404	608	1417	4

SUMMARY

	1954 to 1966	
	33' and Over	32' to 30'
Upbound	13342	11569
Downbound	594	4424
TOTAL	13936	15993

29 or ess	Total all Drafts
,933	26,520
,496	21,921
,429	48,441
,368	35,954
,079	35,510
,447	71,464

1959	
33 and Over	32 to 30
1049	1112
10	331
1059	1443

1966	
33 and Over	32 to 30
1276	219
141	199
1417	418

TABLE III

TRIPS AND DRAFTS OF VESSELS ARRIVING AND DEPARTING DELAWARE RIVER, ALLEGHENY AVENUE, PHILA., PA. TO TRENTON, N.J.

Actual Draft in Feet

Calendar Year	40 or Over	39	38	37	36	35	34	33	32	31	30	29 and Under
1954												
Upbound	–	–	–	–	–	–	–	1	4	8	12	10832
Downbound	–	–	–	–	–	–	–	–	–	–	1	10847
TOTAL	–	–	–	–	–	–	–	1	4	8	13	21679
1955												
Upbound	–	–	–	–	–	–	–	2	3	12	18	15414
Downbound	–	–	–	–	–	–	–	–	–	–	–	15446
TOTAL	–	–	–	–	–	–	–	2	3	12	18	30860
1956												
Upbound	–	–	–	–	–	–	–	1	5	21	13	13612
Downbound	–	–	–	–	–	–	–	–	–	–	–	13770
TOTAL	–	–	–	–	–	–	–	1	5	21	13	27320
1957												
Upbound	–	–	–	–	1	2	1	7	9	13	26	11643
Downbound	–	–	–	–	–	–	–	–	6	20	12	11739
TOTAL	–	–	–	–	1	2	1	7	15	33	38	23382
1958												
Upbound	–	–	–	–	2	1	–	3	8	36	12	11162
Downbound	–	–	–	–	–	–	–	–	–	–	3	11101
TOTAL	–	–	–	–	2	1	–	3	8	36	15	22263
1959												
Upbound	–	–	–	–	–	5	3	10	67	43	73	11673
Downbound	–	–	–	–	–	–	–	45	4	6	5	11810
TOTAL	–	–	–	–	–	5	3	55	71	49	78	23493
1960												
Upbound	–	–	–	–	1	2	9	16	103	139	71	10093
Downbound	–	–	–	–	–	–	–	–	1	3	5	11023
TOTAL	–	–	–	–	1	2	9	16	104	142	76	21116
1961												
Upbound	–	1	12	8	17	22	18	23	49	75	57	11847
Downbound	–	–	–	–	–	–	–	–	2	–	2	12113
TOTAL	–	1	12	8	17	22	18	23	51	75	59	23960
1962												
Upbound	–	19	52	27	22	10	6	13	35	64	30	15150
Downbound	–	–	–	–	–	–	–	–	1	1	6	14922
TOTAL	–	19	52	27	22	10	6	13	36	65	36	30072
1963												
Upbound	–	–	–	–	–	8	7	13	24	30	52	12523
Downbound	–	–	–	–	–	–	–	–	—	–	–	12824
TOTAL						8	7	13	24	30	52	25347
1964												
Upbound	–	–	–	–	16	6	26	37	49	29	58	14246
Downbound	–	–	–	–	–	–	–	1	1	1	9	14402
TOTAL	–	–	–	–	16	6	26	38	50	30	67	28648

9 nd der	Total all Drafts
332	10,857
347	10,848
679	21,705
114	15,449
446	15,446
060	30,895
512	13,652
770	13,720
020	27,372
643	11,702
739	11,777
382	23,479
162	11,224
101	11,104
263	22,328
773	11,874
110	11,874
993	23,748
993	10,434
023	11,032
016	21,466
147	12,129
113	12,114
260	24,243
450	15,428
922	14,930
372	30,358
823	12,657
824	12,824
647	25,881
466	14,467
412	14,414
878	28,881

Y

TABLE III (CONT'D.)

TRIPS AND DRAFTS OF VESSELS ARRIVING AND DEPARTING DELAWARE RIVER, ALLEGHENY AVENUE, PHILA., PA. TO TRENTON, N.J.

Actual Draft in Feet

Calendar Year	40 or Over	39	38	37	36	35	34	33	32	31	30	29 and Under	
1965													
Upbound	15	31	13	37	17	10	28	41	49	34	53	15465	
Downbound	–	–	–	–	–	1	–	2	1	2	5	15807	
TOTAL	15	31	13	37	17	11	28	43	50	36	58	31272	
1966													
Upbound	7	55	14	9	21	13	47	32	24	50	38	14844	
Downbound	–	–	–	–	–	–	–	–	1	2	6	15204	
TOTAL	7	55	14	9	21	13	47	32	26	52	44	30048	

SUMMARY

	Year											
	1954		1955		1956		1957		1958			
	Actual Draft in Feet											
	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	
Upbound	1	24	2	33	1	39	11	48	6	56	18	
Downbound	0	1	0	0	0	0	0	38	0	3	45	
TOTAL	1	25	2	33	1	39	11	86	6	59	63	

	Year												
	1960		1961		1962		1963		1964		1965		
	Actual Draft in Feet												
	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Over	32 to 30	33 and Ove
Upbound	28	313	101	181	149	129	28	106	85	136	192	137	19
Downbound	0	0	0	4	0	8	0	0	1	11	3	8	
TOTAL	28	322	101	185	149	137	28	106	86	147	195	145	19

SUMMARY

	1954 to 1966	
	33' to Over	32' to 30'
Upbound	820	1459
Downbound	49	100
TOTAL	869	1559

9 ad der	Total all Drafts
65	15,793
07	15,818
72	31,611
44	15,153
04	15,213
48	30,366

	1959	
	33 and Over	32 to 30
	18	183
	45	15
	63	198

	1966	
	33 and Over	32 to 30
	198	74
	0	3
	198	77

1 2

TABLE IV

TOTAL NO. OF COLLISIONS AND
GROUNDINGS IN DELAWARE RIVER

Year	Groundings	Collisions	Total Groundings and Collisions	Total Cost
1957	3	4	7	$ 97,000
1958	2	1	3	165,000
1959	3	0	3	0
1960	6	2	8	1,050
1961	0	5	5	1,199,000
1962	1	2	3	198,200
1963	1	4	5	135,000
1964	5	4	9	288,716
1965	0	2	2	50,000
1966	1	5	6	101,360
1967	1	1	2	485,000
	23	30	53	$2,719,966

Average $250,000

Source: U. S. Coast Guard Records